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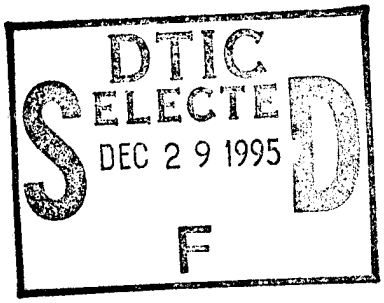

THE COMPARATIVE EFFECTIVENESS OF COMPUTER-MEDIATED COMMUNICATION SUPPLEMENTED SATELLITE DISTANCE EDUCATION AND TRADITIONAL FACE-TO-FACE EDUCATION

THESIS

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THESIS

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Megan C. Block

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Abstract

Satellite distance education delivery typically has one main drawback -- limited student-to-student and student-to-instructor interaction. Telecommunications technology, more specifically computer-mediated communication (CMC), has made it possible for educational institutions to overcome this drawback. This research examines the comparative effectiveness of CMC supplemented satellite distance education delivery and traditional face-to-face education delivery. The three dependent variables that were measured to compare the two educational delivery methods included: performance, interaction, and attitude outcomes. Pre- and post-course instruments were administered in a non-equivalent quasi-experimental design to students enrolled in an Air Force Institute of Technology's School of Systems and Logistics software engineering Professional Continuing Education course. Descriptive statistics and parametric tests were used to analyze these results (at alpha = .05). The parametric tests indicated that the distance education group and traditional group differed significantly on two demographic areas, educational level and self-rated computer proficiency, and on the pretest, final exam and overall course grades. The distance education and traditional group were not significantly different on pre-course attitudes towards computers, midterm exam grades, and post-course instructor and course ratings. It was also discovered that distance education students' mailing list participation rates did not differ between the distance education

students with more positive pre-course attitudes and student with less positive pre-course attitudes.

Despite some negative findings in relation to course performance, the overall results of this study were encouraging. They suggest that satellite distance education that is supplemented with computer-mediated communication can be an effective educational delivery method for software engineering Professional Continuing Education courses.

THE COMPARATIVE EFFECTIVENESS OF COMPUTER-MEDIATED COMMUNICATION SUPPLEMENTED SATELLITE DISTANCE EDUCATION AND TRADITIONAL FACE-TO-FACE EDUCATION

I. Introduction

Introduction

Telecommunications technology has made satellite distance education more feasible and more economical for corporations and universities to deliver training and education to non-local students. With enormous growth in this area, it is important to research the effectiveness of distance education because traditional face-to-face education continues to be considered by many as the "'industry standard' for good quality education" (Phelps and others, 1991:14). This thesis compares the effectiveness of an Air Force Professional Continuing Education (PCE) satellite distance education course that is supplemented with computer-mediated communication (CMC) to the traditional face-to-face course delivery method.

The literature dealing with satellite distance education in various adult populations (undergraduate students, graduate students, non-credit students, and military personnel), consistently indicates that the delivery of educational programming via satellite broadcast is "educationally effective" (Moore, 1990:11). However, standard satellite distance

education methods have always had one main drawback -- limited student-to-student and student-to-instructor interaction (Jegede and others, 1994:91). Some academic institutions are taking advantage of computer-mediated communications to help overcome the problem of limited interactivity. Computer-mediated communication occurs when two or more people communicate electronically over a computer network. The interaction potential of computer-mediated communication appears to be a beneficial supplement to satellite distance education.

Background

The Air Force Institute of Technology's School of Systems and Logistics Software Engineering Department (AFIT/LSS) at Wright-Patterson AFB, Ohio, recently developed a computer-mediated communication portion to supplement their satellite distance education courses. This is the first deliberate attempt by the Air Force Institute of Technology (AFIT) to electronically communicate with its distance education students. Many research efforts have examined the effectiveness of satellite distance educational delivery and the effectiveness of computer-mediated communication educational delivery. However, none have examined the effectiveness of the satellite broadcast used simultaneously with computer-mediated communication in the Air Force Professional Continuing Education (PCE) arena. In the many resources consulted, studies were also abundant in the areas of distance education at civilian institutions using CMC. However, studies of CMC distance education in the Air Force PCE arena were also lacking. Since

this combination of distance education delivery is new to the Air Force, it is deserving of research attention.

Some noteworthy distance education efforts in the military include the Air Force Air Command and Staff College, the Army Reserve Component, and the Department of Defense Dependent schools. The Air Force recently developed an online Professional Military Education course for majors and major selectees (Air Command and Staff College), but the results of their efforts have not been published at this time (Taylor, 1995:2). The US Army Reserve Component conducted a study on the effectiveness and costs of distance education using computer-mediated communication in 1990. They found that students taking the CMC course "achieved test scores no different or better than those of their resident counterparts" (Phelps and others,1991:14). The Department of Defense Dependent Schools (DoDDS) have developed distance education courses using computer conferencing, video taped instruction, and computer tutorials. DoDDS serves a student population of over 150,000, making it the largest American school district. Most of DoDDS schools are relatively small (having between 400 to 700 students each) so offering a variety of classes is sometimes impractical. Distance education was seen as a tool to bring specialty courses, such as Pascal computer programming and calculus, to the DoDDS students who are scattered over eleven different time zones (Morgan and Sheets, 1992:60-61).

Many university instructors have the capability to reach students via the Internet, and those individuals who feel comfortable with this environment are taking advantage of this technology. Richard Smith, co-author of Navigating the Internet, firmly believes that

the widespread access to the Internet will alter the way we educate. He states that "with the collaboration from educators from interdisciplinary backgrounds and from diverse institutions and cultures, education will change from the traditional environment to a virtual classroom with no walls" (Smith, 1994:4). Distance education technologies seem to be expanding at such a rapid pace that it is crucial for educators to continue to research the comparative effectiveness of distance education and traditional education methods. With the new distance education initiative at AFIT, there is a need to research the effectiveness of CMC supplemented satellite distance education in comparison to traditional educational delivery in the Air Force PCE arena.

Problem Statement

The Air Force Institute of Technology's School of Systems and Logistics Software Engineering Department (AFIT/LSS) has developed satellite courses for four of its five Software Professional Development Program (SPDP) resident courses. A traditional AFIT/LSS Professional Continuing Education course is offered in residence for two weeks -- eight hours each day. The five courses are usually taken in a predetermined sequence. The first course in the series, CSE 492, is a prerequisite for all of the remaining SPDP courses (CSE 493, CSE 494, CSE 495, CSE 496). Each software engineering course is graded on a pass/fail basis. Students are required to achieve an overall course grade of 70% to pass. The AFIT/LSS software engineering course listing can be found at Appendix A.

AFIT/LSS has adapted the majority of its courses to be offered by satellite over a 10 week quarter. Each class meets three times a week for one and a half hours a day. The typical satellite course consists of a live, one-way video satellite broadcast from the AFIT host site, located at Wright-Patterson AFB, to multiple remote sites. Each remote site is equipped with push-to-talk microphones that allow a two-way audio connection with the host site. The satellite classroom is also composed of traditional face-to-face students at the AFIT host site.

Students in a traditional classroom setting are able to take advantage of interacting with other students during, before, or after the normal class session. Traditional students can meet with fellow classmates and the instructor in face-to-face meetings to clarify and discuss issues brought up in class. Prior to this initiative, AFIT distance education students had little or no interaction among themselves outside the classroom setting. Since distance education students may not have the opportunity to hold face-to-face discussion groups with other students and cannot meet physically with the instructor, the Software Engineering Department has incorporated computer-mediated communication, in the form of an electronic mailing list, to supplement its satellite courses. By using a mailing list (an electronic mailing program that sends all posted messages to each individual who is subscribed to the mailing list) to provide asynchronous communication during non-class hours, AFIT/LSS has tried to bridge the perceived interaction deficiencies of typical satellite distance education courses.

With the addition of this online educational technology, there is an important need to evaluate distance education courses that are supplemented with computer-mediated

communication. Is satellite distance education delivery supplemented with CMC as good as or better than traditional face-to-face course delivery? With the demand to reach more students, it is imperative to find a suitable distance education delivery for professional continuing education courses that not only allows for interaction between the student and the instructor during classtime, but also allows for the student to communicate with the instructor and other classmates during non-class periods.

Research Objective

The objective of this research was to examine an Air Force software engineering distance education course to determine if CMC supplemented satellite distance education delivery is as good as or better than the traditional face-to-face education delivery method. In particular, were the CMC supplemented satellite distance education course performance, interaction, and attitude outcomes at least as good as the traditional face-to-face education course outcomes?

Hypotheses

This research effort examined the performance, interaction, and attitude outcomes of the distance education group and traditional group by testing five hypotheses. The first hypothesis tested for significant differences on performance scores between the two groups. The second and third hypotheses examined the two groups for differences on the student-to-student interaction and student-to-instructor interaction that occurred during non-class hours. Hypothesis four tested whether more positive pre-course attitudes led to higher mailing list participation rates for the distance education group. The last hypothesis

(hypothesis five) tested for significant differences between the two groups on course and instructor end-of-course ratings. The five research hypotheses are as follows:

Hypothesis 1. H_0: There will be no significant difference between the distance education and traditional students on the scores measuring student performance.
H_a: There will be a significant difference between the distance education and traditional students on the scores measuring student performance.

Hypothesis 2. H_0: The distance education students will not report more interaction with fellow students during non-class hours than the traditional students.
H_a: The distance education students will report more interaction with fellow students during non-class hours than the traditional students.

Hypothesis 3. H_0: The distance education students will not report more interaction with the instructor during non-class hours than the traditional students.
H_a: The distance education students will report more interaction with the instructor during non-class hours than the traditional students.

Hypothesis 4a: H_0: Distance education students with more positive pre-course attitudes towards computers will not be more likely to have higher mailing list participation rates.
H_a: Distance education students with more positive pre-course attitudes towards computers will be more likely to have higher mailing list participation rates.

Hypothesis 4b: H_0: Distance education students with more positive pre-course expectations towards the mailing list will not be more likely to have higher mailing list participation rates.
H_a: Distance education students with more positive pre-course expectations towards the mailing list will be more likely to have higher mailing list participation rates.

Hypothesis 5a: H_0: There will be no significant difference between distance education and traditional students on the post-course survey instructor ratings.
H_a: There will be a significant difference between distance education and traditional students on the post-course survey instructor ratings.

Hypothesis 5b: H_0: There will be no significant difference between distance education and traditional students on the post-course survey course ratings.
H_a: There will be a significant difference between distance education and traditional students on the post-course survey instructor ratings.

Methodology

A one-way (one factor-educational mode) non-equivalent quasi-experimental design was used for this research effort. The experiment design and statistical analysis were based on similar efforts by Cheng and others, as detailed in their article titled, "Comparison of Performance and Attitude in Traditional and Computer Conferencing Classes" (Cheng and others, 1991:55).

The distance education group received the satellite broadcast of the course and participated in computer-mediated communication. The traditional group received the face-to-face instruction that was broadcast to the distance education students. The traditional group did not participate in the CMC. Both the traditional group and distance education group had access to the taped class sessions, in the event that they were unable to attend class during the scheduled time.

Research Instruments

In order to evaluate the research questions, data was collected from each student using pre-and post-course survey instruments. Grade data was provided on each student by the instructor in the following areas: pretest, midterm exam, final exam and overall course grade. The pre-course instruments (the pretest and pre-course survey) established a baseline for assessing learning and attitude changes. The post-course survey provided interaction and attitudinal data. Questions on the pre- and post-course survey were used

with permission from Starr Roxanne Hiltz's research efforts detailed in Online Education: Perspectives in a New Environment (Hiltz, 1990:134). Participation on the mailing list was monitored and was used to determine mailing list participation rates for the distance education students.

Research Assumptions

It was assumed that both sets of students were subjected to the same educational material, surveys, tests and instructor lessons. Important materials, like homework assignments, that were given to the distance education group via the mailing list was presented to the traditional students during normal classtime.

Some of the results obtained may have been affected by the technological experiences encountered with the satellite broadcast and electronic mailing list. If a satellite downlink could not be established, not only do those remote students miss class, and have to get the class on video, but the other students' classtime was also interrupted while the instructor dealt with the problem.

Because this course was a software engineering class, it was assumed that the performance, interaction, and attitude results of the delivery medium were influenced by the computer literacy of the student population and the nature of the course.

Scope and Limitations

This research effort concentrated on a single course offering of a Software Engineering Professional Continuing Education course. Additional research in this area can be conducted with the AFIT Software Engineering PCE courses because AFIT/LSS continues to supplement its satellite distance education courses with an electronic mailing

list. Results from this experiment can be applied to similar courses in the computer science/software engineering field.

Management Implications

With the need to reach more students with less money, it is imperative for the military to develop an effective distance education method. Satellite distance education is now available at most Air Force bases, and with more and more bases becoming connected to the Internet, the possibilities for interaction using computer-mediated communication are endless. New distance education initiatives need to be researched and fine-tuned in order for the military to receive the greatest benefits from new technology.

Organization of the Research

This thesis is organized in five chapters. This chapter, the first one, covers a general introduction of the research experiment. Chapter two defines important terminology and reviews the literature on other distance education research projects. The third chapter describes the methodology used for this experiment. The experiments' results and data analysis can be found in chapter four. The fifth and final chapter details the conclusions and recommendations developed by the researcher.

II. Literature Review

Introduction

This chapter provides a definition of distance education, presents the criteria for evaluating educational delivery and discusses the characteristics of the two distance education methods (satellite and computer-mediated communication (CMC)) that were compared to the traditional classroom delivery method.

Definition of Distance Education

Distance education occurs whenever there is any form of structured education in which the instructor and learner are separated, either physically or in time, and one or more techniques are used to exchange information between them (Harris, 1991:19; Duning, 1993:273). Distance education can offer many of the benefits of traditional classroom instruction: routine interaction between student and teacher, regular monitoring of the student's progress, and varied ways of presenting course material. Many different media deliver distance education. Some examples include: correspondence, radio, videotape, open-broadcast television, cable television, satellite broadcast, computer networks, electronic blackboards, video conferencing, and teleconferencing. The most effective distance education programs use a combination of telecommunications media that suit the needs of their individual courses. "The proliferation of personal computers and the growing accessibility of the Internet and other computer communication services" have made computer-mediated communication more feasible for both students and

teachers (Barreau and others, 1994:10). The main difficulty for educators is not attaining the technological resources, but selecting the best and most economical method for the delivery of their particular distance education program.

Criteria for Evaluating Educational Delivery

Comparison of two or more media in relation to their effectiveness is the most common type of distance education research. With hundreds of media comparison studies having been performed over the last forty years, the results have been fairly solid: the educational method does not "appear to make any important difference in student achievement, attitudes and retention" (Willis, 1994:42). Some of the media comparison studies and the criteria they examined are detailed in the following paragraphs.

The most basic measurement of "desirable outcomes for a course is mastery of the fundamental facts, concepts, and skills that the course is designed to teach" (Hiltz, 1990:144). Mastery, or achievement, is usually tested by assignments and exams that are graded by the professor. However, even though student achievement as measured by course examinations "is an important measure of the success of an educational program, it is almost never the only important measure" (Kinnaman, 1992:18). Some other important and useful evaluation data to consider include performance self-assessment, student and teacher attitudes toward the course, and student and teacher behaviors during the course. Performance assessment focuses on what students can do -- i.e., complete a project successfully. Student attitudes and behavior that are measured by a survey or observation can give insight into the degree a program affects students' effort or motivation. Teacher

attitudes and behavior towards the course and how it may or may not have influenced the students' performance or attitude is another important factor to consider when evaluating the effectiveness of a course (Kinnaman, 1992:18).

Verduin and Clark credit D. Gooler for the basic schemata for assessing distance education program quality and effectiveness in their book Distance Education (Verduin and Clark, 1991:88). The assessment criteria includes: 1) learner outcomes (cognitive skills, psychomotor skills, affective skills and dropout rate); 2) access; 3) quality ; 4) cost effectiveness and efficiency; 5) impact; 6) relevance to needs and expectations; 5) generation of knowledge; and 6) acceptability (status and attitudes). Verduin and Clark's extensive review of the current research revealed distance education achieves most learner outcomes (cognitive, affective and psychomotor) equal to those achieved by traditional education. The dropout rate for distance education is higher than for traditional education and many institutions are making efforts to provide better learning materials and support systems to combat this problem.

Important factors in testing the outcomes of distance education projects, as detailed by Hudson and Boyd, include student performance, performance of hardware and software; complexity of materials' development; and attitudes of teachers, learners, and project staff (Hudson and Boyd, 1984:12). The performance of hardware and software is a factor that needs to be considered when evaluating student attitudes. Frustration with the course media may be attributed to sites not receiving the satellite broadcast or a student not having convenient access to a suitable computer for computer-mediated

communication. Instructors also need to keep the delivery mode and audience in mind when developing their course materials.

In the book Contemporary Issues in American Distance Education, Peter Cookson of Penn State University defines learners' success as one or more of the following outcomes:

1. Persistence:
   (a) provisional registration followed by final registration,
   (b) completion of all course assignments prior to final examination,
   (c) earning of credit following the passing of the final examination.
2. Academic achievement:
   (a) percentage of course assignments successfully competed,
   (b) final course grade.
3. Satisfaction with the course learning experience.
4. Intention to enroll in additional distance education courses.

By keeping in mind these learners' success outcomes, Mr. Cookson believes that a successful distance education course can be designed to attain certain specified and desired outcomes (Cookson, 1990:192).

Each distance education medium incorporates different technologies and thus, the distance education methods that are being researched are deserving of individual attention to the specific characteristics of each medium.

Characteristics of Satellite Distance Education

Satellite networks became possible in the early 1980s, when Hewlett Packard built a satellite network to link California with over one hundred downlink sites in the U.S. and Canada. Most satellite networks consist of one-way video from the transmitting site to the receiving site, with a two-way audio connection being handled by push-to-talk

microphones, videophones, or telephones. The satellite signal can be transmitted terrestrially via microwaves, telephone lines, local cable systems or broadcast stations. Typically, students are sent printed material (either through the mail or via computer) such as the syllabi, assignments, course material and class notes.

According to Bruce Barker and Marvin Platten, in their article "Student Perceptions on the Effectiveness of College Credit courses taught via Satellite," the traditional method of face-to-face educational delivery must be modified to take into account the satellite's interaction parameters. An instructor can teach to a television camera either with or without students in his or her satellite classroom. Using one-way video and two-way audio, the instructor is seen and heard by the remote students, but the instructor cannot see the remote students. Students in the remote classrooms will only be heard by the instructor if those students initiate contact with the instruction site. Once communication has been initiated with the host site, the students at the other remote sites and the host site can hear that particular student's comment (Barker, 1988:45).

One of the major advantages of satellite courses is the ability to reach large audiences. Reaching a large number of students at a given time ensures standardization of course material among those students (Kline, 1993:50). Some of the disadvantages include: remote students are not seen by the instructor and often feel alienated or not included in the class discussions and are disadvantaged by the "lack of opportunity of dialogue, debate, conversational learning, and collaborative work" (Odasz, 1992:70). Because the instructor cannot evaluate remote students based on visual evaluation, some programs have used a facilitator to fill that role.

In a study that examined a satellite broadcast course that was supplemented with computer-mediated communication, Deborah Barreau and her colleagues worked on the Group Collaboration in the Virtual Classroom effort. They tested the hypothesis that "remote [distance education] students will not differ from on-campus students in their reporting of successful collaboration in the virtual classroom." They reported that the majority of the remote and on-campus students reported high levels of satisfaction in the virtual classroom. However, some problems in sharing information and the feeling of isolation were reported by some remote students who were not familiar with CMC (Barreau and others, 1994:10).

Barry Willis, author of Distance Education: Strategies and Tools, points out the reality of satellite distance education -- that "students interact infrequently with instructors both on and off the air" (Willis, 1994:47). With the advent of telecommunications technologies that allow more access to student-to-student and student-to-instructor communication, studying distance education projects that use computer-mediated communication is very important. Some studies have found asynchronous interaction from computer-mediated communication both "very useful and effective" (Willis 1994:49). The characteristics of CMC are detailed in the next section.

Characteristics of Computer-Mediated Distance Education

Computer-mediated distance education occurs over some type of computer network -- either local or global (the Internet). Most computer networks consist of microcomputers, modems (a device that converts digital computer signal into analog

format for transmission over the telephone lines) and a host computer. Together, they transmit and receive information over telephone wires. The host computer acts as a clearinghouse -- receiving, storing, sorting and presenting the material to the appropriate users. Usually, the types of communications media used in computer networks are electronic mail (e-mail), electronic mailing lists, bulletin board systems (bbs), and computer conferencing (Selfe, 1994:116). Electronic mail is "characterized by storage of a message at an 'electronic address' that can be received by the recipient via a telecommunication-equipped personal computer" (Willis, 1994:295). This networking application allows users to send and receive mail messages electronically. An electronic mailing list is a type of group e-mail that subscribes individuals that have an e-mail address and permits sending and receiving e-mail messages to and from everyone subscribed to the mailing list. A mailing list server computer receives e-mail from the subscribers that is intended for posting. The server then duplicates the message and delivers it to everyone subscribed to that mailing list. Electronic mailing list programs can be either unmoderated, where the mailing list program does everything automatically, or moderated, where an individual manually approves all of the requests for subscriptions and postings using the mailing list program commands. Bulletin board systems are electronic storage areas arranged by topics, where remote users can read and post electronic messages to the bbs of their choice. Computer conferencing enables individuals at different locations the ability to communicate directly with each other in a "shared electronic space" (Selfe, 1994:116).

Each online medium links the instructor with the student located at different sites in a different manner (Gransden, 1994:A41). Some are asynchronous, two-way communication in which there is a time delay between when a message is sent and when it is received. Some examples are e-mail, mailing lists and bbs. Computer conferencing is synchronous or real-time, because all participants are online at the same time.

Computer-mediated distance education removes barriers such as social and cultural diversity that are common in the traditional classroom educational setting (Smith, 1:3). Some educators believe that distance education will eventually give most students practically unlimited course options from universities across the globe, "regardless of where they are formally enrolled" (Jacobson, 1994:A23).

With an opportunity for every student to have an equal chance to participate, there is a democratic element inherent in many-to-many computer-mediated communication (Lewis and Hedegaard, 1993:69). Status and role differences tend to be less of a factor in online environments. It is also very difficult for students to hide in CMC environments. "Social loafing becomes more conspicuous because an uninvolved group member literally disappears" (Lewis and Hedegaard, 1993:69). For these reasons, CMC interaction tends to be more evenly distributed when compared to traditional group interaction.

Some characteristics of computer-mediated communication attained in a study at the Houston Community College System (HCCS) include: (1) Immediacy -- especially compared to print-based correspondence distance education; (2) Sense of group identity -- the computer system became a meeting place for students; (3) Improved dialogue -- students interact more compared to the traditional classroom instructional setting; (4)

Improved instructor control -- the computer system can log activities; and (5) Active learning-- student participation improved (Smith, 1994:3).

In The Emerging Worldwide Electronic University, Parker Rossman states that computer-mediated instruction can be as effective as traditional classroom methods. Comparing the results of online courses versus traditional courses, "it was found that the use of the computer-empowered technology actually improved the quality of education." In a computer-mediated environment, the student is not restricted by the limited time available to ask questions in a traditional classroom environment. In front of his or her computer, the student can insert a question, or speak, as often as he or she desires. Online communication encourages students to participate more and thus, allows them to be more in control of their environment (Rossman, 1992:91). The students were more actively involved in self-teaching as well as in joint study projects with fellow students. Online students also report that they kept in closer touch with their teachers, as much as, or more than those students who attended traditional college classes. Mr. Rossman also discussed Starr Roxanne Hiltz's research efforts in the area of online distance education. Ms. Hiltz found that online students (Rossman, 1992:122-123):

> (1) Have test scores as good as those in conventional classrooms if the quality of instruction is the same;
> (2) Report improved access to instructors and convenient access to need courses and educational experiences if they have adequate technology to use; and
> (3) Tend to develop improved ability to collaborate and communicate with other students.

Some studies have shown computer literate individuals will be more accepting of computer-mediated communication technology and their overall attitude towards the class medium will be better on average than those who are not as computer literate (Hiltz, 1993:89). Research has also indicated that distance education computer-mediated courses tend to have the best performance outcomes when the course is computer-related (Hiltz, 1993:94).

S. R. Hiltz also cautions researchers not to equate "lack of use" of the medium by the student with rejection of the medium (Hiltz, 1989:387). The student may not have "convenient access" or sufficient understanding of the medium. She also stresses that requiring students to use the medium may increase usage statistics, while at the same time, building student resentment and dissatisfaction toward the medium (Hiltz, 1989:387). Ms. Hiltz warns that "future studies of CMC should not assume that usage alone or subject satisfaction alone are adequate indicators of acceptance or success" (Hiltz, 1989:397).

In a summary provided by S.R. Hiltz of twelve previous studies of computer-mediated communication acceptance (in terms of amount of use of the system), some of the variables that best predicted CMC acceptance include: previous experience, expectations about the systems, attitudes towards computers, own versus shared terminal, anticipated usefulness, and available night or weekend hours to use the CMC (Hiltz, 1990:743).

Summary

The effectiveness of distance education delivery continues to be a topic of debate. Many studies have come to the conclusion that distance education delivery is as effective as traditional education methods. Since there are so many institutions turning to distance education to reach a larger audience, the effectiveness of distance education methods merits further study (Souder, 1993:37).

This chapter defined distance education and gave examples of distance education media. Criteria for evaluating educational delivery and the characteristics of satellite and computer-mediated communication distance education were also discussed. The focus of this research effort will be on three dependent variables -- performance, interaction, and attitude outcomes. Performance and attitude outcomes were chosen because of the number of media comparison studies that used these variables to determine whether distance education is as good as or better than traditional education. Interaction outcomes were chosen because of the new initiative to supplement the satellite broadcast with a mailing list. In particular, do the more positive distance education students (in terms of expectations of the CMC system and pre-course attitudes towards computers) have higher participation rates? These variables also appear to be the most measurable in the pre-course/post-course survey and test format. The next chapter will explain the methodology that was chosen to study these dependent variables.

III. Methodology

Introduction

This chapter will discuss the non-equivalent control group methodology that was used to analyze the performance, interaction, and attitude outcomes of the Air Force Institute of Technology's School of Systems and Logistics Software Engineering Departments' (AFIT/LSS) Object Oriented Analysis and Design (CSE 494) Software Professional Development Program course. The Object Oriented Analysis and Design course is a Professional Continuing Education (PCE) course that is graded on a pass/fail basis. Students in CSE 494 were required to achieve an overall course grade of 70% to receive a passing grade.

Description of Educational Delivery

The AFIT/LSS software engineering satellite courses are offered over a 10 week quarter, being held for one and a half hours a day, three times a week. This particular satellite course consisted of a live, one-way video satellite broadcast from the Air Force Institute of Technology site located at Wright-Patterson AFB, to multiple downlink sites at other Air Force bases. Each site, including the AFIT site, had a two-way audio connection with push-to-talk microphones. These microphones allowed remote students to communicate with the instructor and the other students. The satellite classroom at AFIT was composed of traditional face-to-face students who also used the push-to-talk microphones to communicate with the other sites. Each site recorded the satellite

broadcast and distributed the videotapes to students who were unable to attend class. The remote sites that could not receive the broadcast were sent copies of the lectures for distribution to their distance education students.

The AFIT satellite classroom was equipped with multiple cameras for different filming angles, a white board, overhead projector, two television monitors that displayed the live broadcast, push-to-talk microphones located on each host site's student desk, and an uplink to the remote sites. The remote classrooms were located at base education centers of other Air Force bases. Each remote classroom was equipped with a television monitor, push-to-talk microphones for each student, a video cassette recorder and a satellite downlink to receive the AFIT broadcast.

Computer-mediated communication (CMC) in the form of a moderated mailing list was used to facilitate discussion among the remote students. To better isolate the effects of the CMC on the satellite students, it was necessary to exclude the traditional students from the mailing list. However, the traditional students were allowed to discuss issues outside the class sessions with other traditional students and the instructor.

The researcher acted in the capacity of the moderator with the ability to subscribe students, unsubscribe students, and forward all appropriate electronic mail received to all of the subscribers on the mailing list. The remote students were required to subscribe to the mailing list by the end of the first week of class, check their electronic mail account a minimum of three times a week and contribute to the mailing list at least once every two weeks. These mailing list requirements were detailed to the students on the first day of class in the handout located at Appendix B. The instructor sent out two to three messages

each week pertaining to the course, course material, homework assignment or feedback requests on educational technology, instructor delivery or course content to the subscribers of the mailing list.

The areas of responsibility for the researcher, instructor, test site administrators, course administrator and computer systems administrator and the timeframe of completion for each task for this research project can be found at Appendix C.

Research Design

Since the distance education group and traditional group were not randomly assigned, this field experiment was set up in the nonequivalent control group design, and more specifically, an intact equivalent group design -- where both groups of students were assembled naturally (Cooper and Emory, 1995:368, Campbell and Stanley, 1963:47). The nonequivalent control group design is diagrammed as follows (Cooper and Emory, 1995:368):

O_1 X O_2

O_3 O_4

The O refers to some process of observation or measurement and the X represents the exposure of the distance education group to the experimental variable -- educational delivery by satellite/CMC. The Xs and Os in a given row are applied to the same group. The absence of the symbol R indicates that the assignment to treatment groups is nonrandom. The dashed line also indicates that the two groups are not equated by random assignment (Campbell and Stanley, 1963:6).

The distance education group, composed of the students at the remote sites, received the live satellite broadcast supplemented with computer-mediated communication. The traditional group, composed of the local Wright-Patterson students, received the face-to-face instruction that was not supplemented with CMC. The two groups are defined as follows:

> *Distance education:* A 'traditional' satellite broadcast course to the remote site students. Students and instructor were geographically separate. Lessons were viewed at the remote base's education center. Homework assignments were completed through electronic mail, facsimile transmissions and written correspondence. Exams and surveys were completed under the supervision of the education center's test administrator and were sent to and from the remote site by certified mail. The student's direct contact with the instructor and other students during class was with the push-to-talk microphones and during non-class hours, contact was over the mailing list, direct e-mail or telephone contact.
>
> *Traditional:* A traditional lecture course that was modified for satellite broadcast. Lessons were held in the AFIT satellite classroom and students were responsible for using the push-to-talk microphones whenever they discussed items during classtime. Students had direct contact with the instructor and host site students three times a week during classtime. During non-class hours, students had access to telephone and face-to-face contact with the other students and the instructor. Exams and surveys were administered by the instructor during classtime.

Both sets of students were subjected to the same material, homework assignments, surveys, exams and instructor -- ensuring a commonality of learning processes and objectives.

Population

The population consisted of the Air Force Software Engineering students who met the attendance prerequisites as detailed in the AFIT School of Systems and Logistics PCE FY95 catalog. "Students must be accepted into the Software Professional Development Program (SPDP), which requires a bachelors degree with a strong computer science background. In addition, students must have computer programming experience and a basic knowledge of data structures and algorithm analysis" (AFIT/LS PCE catalog, 1995:53).

Sample

The sample consisted of the students who voluntarily enrolled in the AFIT/LSS Object Oriented Analysis and Design (CSE 494) software engineering course. The students were required to have already taken the prerequisite, Software Systems Engineering (CSE 492). The class was in session from 10 July 1995 to 22 September 1995. The Object Oriented Analysis and Design course enrolled 51 distance education students and 12 traditional face-to-face students from Wright Patterson AFB. The distance education participants were be the remote students located at other Air Force bases that received the satellite broadcast (19 downlink sites). The remote sites consisted of as many as 11 students and as few as one student.

Hypotheses

This research effort examined the performance, interaction, and attitude outcomes of the distance education group and traditional group by testing five hypotheses. The first hypothesis tested for significant differences on performance scores between the two groups. The second and third hypotheses examined the two groups for differences on the student-to-student interaction and student-to-instructor interaction that occurred during non-class hours. Hypothesis four tested whether more positive pre-course attitudes led to higher mailing list participation rates for the distance education group. The last hypothesis (hypothesis five) tested for significant differences between the two groups on course and instructor end-of-course ratings. The five research hypotheses that were tested are as follows:

> Hypothesis 1. H_0: There will be no significant difference between the distance education and traditional students on the scores measuring student performance.
> H_a: There will be a significant difference between the distance education and traditional students on the scores measuring student performance.
>
> Hypothesis 2. H_0: The distance education students will not report more interaction with fellow students during non-class hours than the traditional students.
> H_a: The distance education students will report more interaction with fellow students during non-class hours than the traditional students.
>
> Hypothesis 3. H_0: The distance education students will not report more interaction with the instructor during non-class hours than the traditional students.
> Ha: The distance education students will report more interaction with the instructor during non-class hours than the traditional students.
>
> Hypothesis 4a: H_0: Distance education students with more positive pre-course attitudes towards computers will not be more likely to have higher mailing list participation rates.
> H_a: Distance education students with more positive pre-course attitudes towards computers will be more likely to have higher mailing list participation rates.

Hypothesis 4b: H_0: Distance education students with more positive pre-course expectations towards the mailing list will not be more likely to have higher mailing list participation rates.
H_a: Distance education students with more positive pre-course expectations towards the mailing list will be more likely to have higher mailing list participation rates.

Hypothesis 5a: H_0: There will be no significant difference between distance education and traditional students on the post-course survey instructor ratings.
H_a: There will be a significant difference between distance education and traditional students on the post-course survey instructor ratings.

Hypothesis 5b: H_0: There will be no significant difference between distance education and traditional students on the post-course survey course ratings.
H_a: There will be a significant difference between distance education and traditional students on the post-course survey instructor ratings.

Data Collection Methodology

Research Instruments. In order to evaluate the above hypotheses, data was collected from each student using the following pre-and post-course research instruments: pretest, midterm exam, final exam, overall course grade, pre-course survey, post-course survey and participation rates.

Performance was measured by the grades received on the pretest, the midterm exam, the final exam and the overall course. Mailing list participation rates for distance education students were computed by the number of postings that were contributed by each student during the duration of the course (Appendix D).

Student demographic data was collected on the pre-course survey (Appendix E). Some of the student characteristics that were collected include: age, sex, present job title,

time in present job, time working in the software engineering field, current course load, experience with computers, number of courses in software engineering and level of education. An explanation of how some of the demographic data were coded can be found at Appendix F.

The pre-course survey also posed Likert-type scale questions pertaining to attitudes towards computers, computer experience, and connectivity issues. In addition, the pre-course survey collected the distance education group's expectations for the mailing list.

The post-course survey (Appendix G) posed Likert-type scale questions pertaining to time spent on the course, experience with the mailing list, time spent using the mailing list, the course and the instructor rating. The post-course survey also collected data on experience with the mailing list for the distance education group.

To protect the student's privacy, names were not necessary for this research. However, the last four digits of the students' social security numbers were used to match the results of the pre- and post-course research instruments. Refusal to complete any survey, under the protection-of-human rights subjects' regulations, did not affect the student's grades in any way.

Instrument Construction. The pretest, midterm exam, and final exam were constructed and graded by the instructor. The pretest, designed specifically by the instructor for this experiment, was used to establish a baseline performance score for each student. An overall course grade for each student was determined by the instructor from his or her test and homework scores.

The pre- and post-course surveys were constructed by the researcher. Questions on demographics (#1-21) were developed by the researcher. Attitudinal questions (pre-course #22-39, post-course #4-37) were developed by Starr Roxanne Hiltz for the evaluation of the Virtual Classroom (registered trademark) found in Chapter 7 (p.134) of Online Education: Perspectives on a New Environment, edited by Linda M. Harasim, 1991. These questions were used with permission, as given on page 134.

Both pre-course and post-course surveys were evaluated by software engineering instructors, as well as AFIT graduate faculty members, for content and research suitability.

Instrument Administration. The pretest and pre-course survey were administered on the second day of class by the instructor for the traditional group, and by the base education centers' test administrators for the distance education group. The final and post-course survey was administered on the last day of class. The distance education group's survey and test instruments were sent to and from the education centers by certified mail.

Data Analysis

The performance, interaction, and attitude outcomes served as the dependent variables for this study. The dependent variables, the independent variables and how each were specifically measured can be found at Appendix H. In general, the first dependent variable, performance outcome, was measured by grades from the pretest, the midterm and final exams, and the overall course. The second dependent variable, interaction outcome, was measured by the responses given on the Likert-type post-course survey interaction questions. The final dependent variable, attitude outcomes, was measured by:

1) the pre-course survey of student's attitudes toward the computer, the course, and the delivery medium; and 2) the post-course survey of the student's attitudes toward the computer, course content, course delivery, instructor, and course.

Much consideration was given to Cooper and Emory's discussion of evaluating ordinal scales (Cooper and Emory, 1995:145). Cooper and Emory detail the differences of opinion among behavioral scientists on using parametric over nonparametric methods to evaluate ordinal data found in Likert-type questionnaires. "One position is that the use of parametric tests is incorrect on both theoretical and practical grounds... At the other extreme, some behavioral scientists argue that parametric tests are usually acceptable for ordinal scales" (Cooper and Emory, 1995:145). There is also a view between these two extremes that recognizes there are risks -- but these risks are usually not significant. Kerlinger, one of Cooper and Emory's contributors, states that the best procedure is to "treat ordinal measurements as though they were interval measurements but to be constantly alert to the possibility of *gross* inequality of intervals" (Cooper and Emory, 1995:145). In light of these opinions, this researcher decided to use parametric statistical tests on all five hypotheses.

All dependent variables, including performance, interaction, and attitudes were analyzed by either a one-way analysis of variance (ANOVA) or a Student's t-Test. All tests were evaluated at a 95% confidence interval (alpha = .05).

Demographic data on the pre-course survey was used to compare the homogeneity of the two groups. The demographic data for each question was grouped into categories, and each category was assigned an ordinal ranking for purposes of comparison. A one-

way ANOVA was completed on each demographic question to determine if there was a significant difference between the two groups. A similar test on attitudes towards computers was also conducted on the two groups. Only those students who completed a pre-course survey were considered in this test.

Performance scores for each test and overall grade was analyzed by a one-way ANOVA between the two groups. Only those students completing both the pretest and posttest measures were included in this Student's t-Test analysis.

Interaction outcomes were compared between the two groups by conducting a one-tailed Student's t-Test on the post-course survey questions on student-to-student and student-to-instructor interaction.

A one-tailed Student's t-Test was also conducted on the distance education group to determine if students with more positive pre-course attitudes towards computers and the mailing list had higher participation rates.

Student attitudes on the instructor and course were analyzed by a one-way ANOVA for each post-course survey question for significant differences between the two groups. A two-tailed Student's t-Test was conducted on the combined instructor and course ratings to test for significant differences between the two groups.

Summary

This chapter covered the description of the educational delivery, the general research approach, the hypotheses intended to be tested, the population and sample of subjects to

be studied, and the data collection methodology and data analysis methods that were used to test the hypotheses. The next chapter will present the results and analysis of the experiment.

IV. Results and Analysis

Introduction

This chapter presents the descriptive statistics and corresponding statistical test statistics for the data and hypotheses described in the methodology chapter.

The dependent variables analyzed in this study were performance, interaction, and attitude outcomes. The first dependent variable, performance outcome, was measured by grades from the pretest, the midterm and final exams, and the overall course average. The second dependent variable, interaction outcome, was measured by the responses given on the post-course survey interaction questions. The final dependent variable, attitude outcomes was measured by responses from the pre- and post-course survey and mailing list participation rates.

Descriptive statistics (demographic data and attitudes towards computers) from the pre-course survey were used to compare the homogeneity of the two groups. A one-way analysis of variance (ANOVA) was completed on each question to determine if there was a significant difference between the distance education and traditional groups. Only those students who completed the pre-course survey were included in this analysis.

All dependent variables were analyzed by either a one-way analysis of variance or a Student's t-Test. All statistical tests were conducted at a confidence level of 95% (alpha = .05). Data was analyzed using the Microsoft EXCEL (registered trademark) spreadsheet package.

There were sixty-three students enrolled in the course for Professional Continuing Education (PCE) credit -- twelve were from Wright-Patterson and fifty-one were distance education students. Eleven students (all distance education) withdrew from the course. At the time of this writing, two distance education students had incomplete final and overall course grades due to extensive travel scheduling problems that kept them from completing the course.

Descriptive Statistics

Demographic Data. A one-way analysis of variance was conducted on each demographic question to determine if the distance education and traditional groups were significantly different. This test was conducted to compare the homogeneity of the two groups. Only those students who completed a pre-course survey were considered in this test (25 from the distance education and 10 from the traditional group). The results of the one-way ANOVA are in Table 1.

The ANOVA revealed the two groups were not significantly different, except on two aspects -- education level and self-rated computer proficiency. In both cases, the traditional group scored higher -- meaning the traditional group had higher educational levels and higher computer proficiency self-ratings compared to the distance education group.

Table 1

Demographic Data								
Variables	Distance Education			Traditional			ANOVA	
	n	Mean	S.D.	n	Mean	S.D.	Sig. of F	Sig
1. SEX (1=male, 2=female)	25	1.12	0.331	10	1.1	0.316	0.8714	
2. AGE (# of years)	25	34.4	7.847	10	34	8.323	0.8942	
3. MILITARY (1=yes, 2=no)	25	1.68	0.4761	10	1.7	0.483	0.9116	
4. RANK/GRADE (1=JR, 2=SR)	25	1.76	0.4359	10	1.9	0.316	0.3643	
7. MONTHS IN CURRENT JOB	25	43.8	41.46	10	38	34.467	0.6985	
8. S/W ENGR JOB (1=yes, 2=no)	25	1.08	0.2769	10	1	0	0.3718	
9. LENGTH IN S/W FIELD (Months)	25	78.72	66.309	10	94.7	73.43	0.5362	
10. ED LEVEL (1=undergrad, 2=some grad, 3=grad)	25	1.76	0.8306	10	2.5	0.7071	0.0186	*
11. # UNDERGRAD S/W ENGR CREDITS	23	5.957	11.534	7	3	3.464	0.5135	
12. # GRAD S/W ENGR CREDITS	22	4.136	9.13	8	3.75	4.4641	0.9101	
13. # PCE S/W ENGR COURSES	23	2.652	1.7992	9	2	1.2247	0.3273	
14. TIME EXPECTED (1=<1hr,2=1-2hr,3=2-3hr,4=>3hr)	24	3.208	0.8836	9	2.667	0.7071	0.1097	
17. COMPUTER PROFICIENCY(1=no exp. to 5=very)	24	3.958	0.8587	9	4.778	0.1944	0.0108	*
20. USE E-MAIL (1=frequently to 7=never)	25	1.96	1.5132	9	1.222	0.6663	0.1701	
21. MAILING LIST MEMBER (1=yes, 2=no)	25	1.48	0.6	9	1.111	0.3333	0.0529	

Attitudes Towards Computers Data. In order to establish a similarity between the two groups on attitudes toward computers, the pre-course survey data on attitudes towards computers was analyzed using a one-way ANOVA between the distance education group and traditional group. The results listed in Table 2 indicate no significant differences between the groups on attitudes towards computers.

Table 2

Attitudes Towards Computers Data								
Variables	Distance Education			Traditional			ANOVA	Sig
	n	Mean	S.D.	n	Mean	S.D.	Sig. of F	
22. STIMULATING VS DULL	25	2.2	1.041	9	2.111	1.05	0.828	
23. FUN VS DREARY	25	2.2	1.08	9	1.77778	0.66666	0.28222	
24. EASY VS DIFFICULT	25	2.52	1.388	9	1.88889	0.78174	0.20822	
25. PERSONAL VS IMPERSONAL	25	3.44	1.73397	9	3.66667	1.73205	0.73879	
26. HELPFUL VS HINDERING	25	2.12	1.20138	9	2.22222	1.3017	0.83169	
27. NON THREATENING VS THREATENING	25	1.96	1.17189	9	2.55556	1.424	0.22553	
28. EFFICIENT VS INEFFICIENT	25	2.4	1.354	9	2.22222	0.66667	0.71003	
29. OBLIGING VS DEMANDING	25	3.28	1.54164	9	4.11111	1.53659	0.17473	
30. DESIRABLE VS UNDESIRABLE	25	1.84	1.02794	9	1.88889	1.05409	0.904	

Performance Data

Performance scores for each exam and overall course grade were analyzed by a one-way ANOVA between the two groups. The grades received on the instructor-developed exams were used to test the following hypothesis:

> Hypothesis 1. H_0: There will be no significant difference between the distance education and traditional students on the scores measuring student performance.
>
> H_a: There will be a significant difference between the distance education and traditional students on the scores measuring student performance.

The results of the one-way ANOVA test on the grades for the traditional and distance education group are below in Table 3.

Table 3

Grade Data								
Variables	Distance Education			Traditional			ANOVA	Sig
	n	Mean	S.D.	n	Mean	S.D.	Sig. of F	
Pretest	28	55.35	20.146	11	76.66	18.76	0.004	*
Midterm	40	83	10.178	12	89.167	5.967	0.092	
Final	38	68.2	14.9	12	77.917	8.8468	0.038	*
Overall	38	83.29	12.36	12	91.75	6.312	0.028	*

The null hypothesis for performance was rejected for the pretest, final exam and overall course grades (significance of F was less than alpha (.05)). There was a significant difference between the distance education and traditional students on the scores measuring student performance on the pretest, final exam and overall course grade. However, there was no significant difference between the distance education and traditional groups on the midterm exam scores (significance of F was not less than alpha (.05)).

Interaction Data

Interaction outcomes were compared between the traditional and distance education groups by conducting a one-tailed Student's t-Test on the post-course survey questions on student-to-student and student-to-instructor interaction.

Student-to-student interaction during non-class hours was compared using the post-course survey question #2. Question #2 was a 6-point Likert-type question that asked "How often did you communicate with other students outside of class, by computer, 'face-to-face' or on the telephone?" The possible choices were as follows: 1-never, 2-rarely, 3-sometimes, 4-often, 5-frequently, 6-constantly. The following hypothesis was tested:

> Hypothesis 2. H_0: The distance education students will not report more interaction with fellow students during non-class hours than the traditional students.
>
> H_a: The distance education students will report more interaction with fellow students during non-class hours than the traditional students.

The two groups were also compared on student-to-instructor interaction. Post-course survey question #3 was used to test the following hypothesis:

> Hypothesis 3. H_0: The distance education students will not report more interaction with the instructor during non-class hours than the traditional students.
>
> H_0: The distance education students will report more interaction with the instructor during non-class hours than the traditional students.

The results of the one-tailed Student's t-Tests for hypothesis 2 and 3 are listed below in Table 4.

Table 4

Student's t-Test Results of Student-to-Student and Student-to-Instructor Interaction							
Variables	n	Mean	S.D.	t-value	d.f.	1-tailed prob	significant
Student-to-Student							
Distance Education	24	2.8	1.279				
Traditional	10	3.375	0.9189	-1.2851	35	0.103999	
Student-to-Instructor							
Distance Education	24	2.41667	1.018				
Traditional	10	2	0.6667	-1.187	32	0.121984	

Both null hypotheses 2 and 3 were not rejected. There was no significant difference in student-to-student or student-to-instructor interaction rates between the two groups.

Attitude Data

A one-tailed Student's t-Test was conducted on the distance education group to determine if students with more positive pre-course attitudes towards computers and the mailing list had higher mailing list participation rates. It was hypothesized that student's with more positive pre-course attitudes about computers and the educational medium will have higher mailing list participation rates and be more accepting of the mailing list technology and thus, participate more. The pre-course attitudes towards computers questions (#22-30) and pre-course expectations for the mailing list (questions # 31-38) were used in evaluating the following hypotheses:

> Hypothesis 4a: H_0: Distance education students with more positive pre-course attitudes towards computers will not be more likely to have higher mailing list participation rates.

H_a: Distance education students with more positive pre-course attitudes towards computers will be more likely to have higher mailing list participation rates.

Hypothesis 4b: H_0: Distance education students with more positive pre-course expectations towards the mailing list will not be more likely to have higher mailing list participation rates.

H_a: Distance education students with more positive pre-course expectations towards the mailing list will be more likely to have higher mailing list participation rates.

The distance education group's responses to the pre-course survey questions were totaled and averaged for each student (7-point Likert-type questions, 1 being positive and 7 being negative). The averages for the group were analyzed and divided into more positive and less positive groups by the researcher. The students with the most positive averages were included in the more positive group and the students with the least positive averages were included in the less positive group. The group sizes are unequal because the more positive students had several averages with the same value, making the division line between the two groups difficult to ascertain. The students in the more positive pre-course computer attitudes group had averages between 1 and 2.333 and the students in the less positive pre-course computer attitudes group had averages between 2.556 and 3.44. The students with the more positive pre-course expectations towards the mailing list had averages from 1.42 to 3.71. While the students with more negative pre-course expectations towards the mailing list had averages from 3.857 to 6.16. The number of mailing list postings for the more positive and less positive groups were compared and analyzed with a one-tailed Student's t-Test. Results of that test are located in Table 5.

Mailing list participation rates for distance education students were computed by the number of postings that were contributed by each student during the duration of the course. Some students did not participate at all (count of 0), while others had 4 or 5 contributions.

Table 5

Student's t-Test Results of Pre-course Attitudes and Mailing List Participation							
Variables	n	Mean	S.D.	t-value	d.f.	1-tailed prob	significant
Computer Attitudes (4a)							
More Positive	13	1.385	1.6602				
Less Positive	10	1.2	1.2293	0.2944	21	0.385672	
Expectations of Mailing List (4b)							
More Positive	13	1.5	1.6132				
More Negative	10	1	1.2472	0.87228	21	0.19646	

The null hypothesis was not rejected for either hypothesis 4a or hypothesis 4b (1-tailed probability is not less than alpha (.05)). There was no significant difference between the two groups -- more positive pre-course attitudes towards computers and more positive pre-course expectations towards the mailing list did not seem to effect mailing list participation rates.

In an effort to determine whether the treatment affected the attitudes about the mailing list for the distance education group, the following (unnumbered) hypothesis was tested using a one-way analysis of variance:

> Hypothesis: H_0: There will be no significant difference between the pre-course expectation about using the mailing list and post-course experience with the mailing list.

H_a: There will be a significant difference between the pre-course expectation about using the mailing list and post-course experience with the mailing list.

Results from the one-way ANOVA are located in Table 6 below.

Table 6

Expectations vs Experience with Mailing List								
Variables	Pre-course			Post-course			ANOVA	Sig
	n	Mean	S.D.	n	Mean	S.D.	Sig. of F	
Pre31/Post28 EASY VS HARD TO LEARN	23	2.3913	1.3396	24	1.79167	0.8836	0.075577	
Pre32/Post29 FRIENDLY VS IMPERSONAL	23	2.826	1.2668	24	2.875	1.5691	0.90716	
Pre33/Post30 NOT FRUSTRATING VS FRUSTRATING	25	3.4	1.9149	24	3.125	1.8954	0.615881	
Pre34/Post31 PRODUCTIVE VS NOT PRODUCTIVE	25	3.68	1.9305	24	4.16667	1.7611	0.306187	
Pre35/Post32 MAILING LIST AND EFFICIENCY	25	4.08	1.6371	24	4.95833	1.6545	0.065754	
Pre36/Post33 MAILING LIST AND QUALITY	24	4.04167	1.6011	24	4.95833	1.8528	0.073145	
Pre38/Post37 OVERALL MAILING LIST	24	4.04167	1.6545	24	4.5	1.6681	0.344221	

The results of the one-way analysis of variance indicate that there were no significant differences between the mailing list expectations and the mailing list experiences with the distance education group at the 95% confidence level. The null hypothesis was not rejected for any of the variable questions.

The last attitudinal hypotheses to be tested dealt with instructor and course ratings. This research effort was interested in testing whether the groups differed in their ratings on the course and the instructor. Student attitudes on the instructor and course were analyzed by a one-way ANOVA for each post-course survey question for significant differences between the two groups. A two-tailed Student's t-Test was conducted on the combined instructor and course ratings to test for significant differences between the two groups. The following hypotheses were tested using a one-way ANOVA (results are found below in Table 7 and 8) on the 5-point Likert-type questions regarding instructor and course ratings (1-strongly agree to 5-strongly disagree):

Hypothesis 5a: H_0: There will be no significant difference between distance education and traditional students on the post-course survey instructor ratings.

H_a: There will be a significant difference between distance education and traditional students on the post-course survey instructor ratings.

Hypothesis 5b: H_0: There will be no significant difference between distance education and traditional students on the post-course survey course ratings.

H_a: There will be a significant difference between distance education and traditional students on the post-course survey instructor ratings.

Table 7

Instructor Ratings Data								
Variables	Distance Education			Traditional			ANOVA	Sig
	n	Mean	S.D.	n	Mean	S.D.	Sig. of F	
7. INSTRUCTOR ORGANIZED COURSE WELL	24	2.5	1.02151	10	2.4	0.96609	0.79344	
8. GRADING WAS FAIR AND IMPARTIAL	24	2.5417	0.88363	10	2.2	0.63246	0.27699	
9. INSTRUCTOR SEEMS TO ENJOY TEACHING	24	2.0833	0.71728	10	2.1	0.87559	0.95421	
10. INSTRUCTOR HAS SUFFICIENT KNOWLEDGE	24	2.0417	0.75062	10	1.8	0.63246	0.37874	
11. ENCOURAGED TO EXPRESS IDEAS	24	1.75	0.74399	10	1.7	0.67494	0.86277	
12. MATERIAL PRESENTED CLEARLY	24	2.125	0.67967	10	2.3	1.05934	0.56748	
13. INSTRUCTOR DISCUSSED OTHER POVs	24	2.4167	0.97431	10	2.5	0.97183	0.82156	
14. ABLE TO GET PERSONAL HELP	24	2.375	1.05552	10	1.9	0.56764	0.19076	
15. MATERIAL PRESENTED INTERESTINGLY	24	2.5833	0.97431	10	3.2	1.03279	0.10809	
16. WORK CRITIQUED CONSTRUCTIVELY	24	2.9583	1.29297	10	2.6	0.69921	0.37187	
17. OVERALL RATING OF INSTRUCTOR	24	2.5	0.88465	10	2.6	0.96609	0.77179	

Table 8

Course Ratings Data								
Variables	Distance Education			Traditional			ANOVA	Sig
	n	Mean	S.D.	n	Mean	S.D.	Sig. of F	
18. COURSE MADE ME MORE INTERESTED	24	2.4167	1.100006	10	2.1	0.73786	0.41165	
19. LEARNED A GREAT DEAL	24	2	0.93251	10	1.8	0.42164	0.5224	
20. GAINED GOOD UNDERSTANDING	24	2.2083	0.977093	10	1.9	0.56765	0.35962	
21. LEARNED TO IDENTIFY CENTRAL ISSUES	24	2.25	0.989071	10	2.1	0.73786	0.66959	
22. COMMUNICATE CLEARLY	24	2.375	0.969698	10	2	0.66666	0.27384	
23. COURSE WAS A GOOD USE OF TIME	24	2.2917	0.954584	10	1.7	0.67495	0.08518	
24. DEVELOPED NEW FRIENDSHIPS	24	2.875	1.153916	10	3.4	0.9669	0.21569	
25. LEARNED TO VALUE OTHER POVs	24	2.4583	0.867754	10	2.4444	0.72648	0.96817	
26. OVERALL COURSE RATING	24	2.66667	0.816489	10	2.3	0.67495	0.22033	

The results from all of the ANOVA tests indicate that there were no significant differences on the instructor ratings or course ratings between the distance education and traditional groups. The recommendation of these tests was to not reject the null hypothesis for hypothesis 5a or 5b.

Summary

This chapter presented the descriptive statistics and corresponding statistical test statistics for the data and hypotheses described in the previous chapter. All statistical tests were conducted at a confidence level of 95% (alpha = .05). It was discovered that there were no significant differences on the descriptive statistics (demographic data and computer attitudes) between the two distance education and traditional groups with only two exceptions -- educational level and self-rated computer proficiency. (The traditional group rated higher on both.) There appeared to be a significant difference between the groups on the pretest, final exam and overall course grades, but not on the midterm exam grades. On the basis of student-to-student interaction and student-to-instructor interaction, no significant differences between the two groups were noted. When testing

the distance education group for positive pre-course attitudes and participation rates, it was discovered that there was no significant difference between positive and negative attitudes and participation rates. The tests also showed that the treatment did not affect the attitudes towards the mailing list for the distance education group. On the last hypothesis, no significant difference on the instructor and course ratings was noted between the distance education and traditional group.

The final chapter of this thesis will draw conclusions and recommendations from the above results and analysis.

V. Conclusions and Recommendations

Introduction

Many educators recognize that the biggest drawback to satellite distance education is the lack of interaction capabilities for the remote student. As educational institutions attempt to overcome this drawback, some are integrating computer-mediated communication (CMC) with the satellite distance educational delivery. This research effort was designed to analyze the comparative effectiveness of an Air Force Institute of Technology software engineering CMC supplemented satellite distance education course to the traditional educational delivery method.

This chapter summarizes the conclusions drawn from the analysis performed in the previous chapter, in effect answering the research questions set forth by this research project. Limitations of the research, recommendations for further, and a summary of the research effort are also presented in this chapter.

Conclusions of Results and Analysis

Descriptive Statistics. The one-way ANOVA test for each demographic question revealed that there were significant differences between the two groups on educational level and self-rated computer proficiency. The traditional group rated higher on both accounts. This is not surprising because Wright-Patterson is a highly technical base, and the nature of the jobs require more educational experience (and possibly more computer

experience) on the whole, when compared to other bases. The significant differences on these items could explain some of the observed differences on performance outcomes.

On attitudes toward computers, it was hypothesized that there would be no significant differences between the distance education and traditional groups. A one-way ANOVA test between the distance education group and traditional group on the pre-course survey on attitudes towards computers indicated that there were no significant differences between the groups. Due to the nature of this course (computer oriented), these results do not come as a surprise. If there had been a significant difference between the two groups, with the traditional group rating higher, it could be hypothesized that differences in computer attitudes affected performance in the course. However, this was not the case in this experiment.

Performance Data. After conducting a one-way ANOVA on the grade data, it was discovered that there was a significant difference between the groups on the pretest, final and overall course grades, but not on the midterm grades. The significant differences can be attributed to the differences in education level and self-assessed computer proficiency between the two groups. Since the traditional group had higher education levels and rated themselves higher on computer proficiency, it seems logical that they would score higher than the distance education group. However, this assessment does not explain the midterm grades. Because there was no significant difference between the traditional and distance education group on the midterm, one cannot automatically assume that different educational backgrounds will lead to differences in test scores. However, the lack of difference between the two groups can be explained by other reasons -- such as leniency in

the instructor's grading procedures (i.e., the instructor curved grades to boost the overall performance of the class).

Interaction Data. When the student-to-student interaction and student-to-instructor interaction rates outside the classroom were tested with a Student's t-Test, it was discovered that there were no significant differences between the two groups. With no significant differences between the two groups, it can be hypothesized that the mailing list enabled the distance education group to achieve comparative interaction rates to the traditional group. The mailing list provided the distance education students with an opportunity to interact with other students and the course instructor.

Attitude Data. When testing the hypothesis that more positive pre-course attitudes towards computers led to higher participation rates among the distance education students, it was discovered that there were no significant differences between positive and negative computer attitudes on mailing list participation rates. The Student's t-Test also revealed that there were no significant differences between positive and negative expectations of the mailing list and mailing list participation rates. Another test revealed that the treatment did not affect the attitudes about the mailing list for the distance education group -- there was no significant difference between the pre-course expectation about using the mailing list and post-course experience with the mailing list. It would have been more favorable to show that the treatment positively affected attitudes toward the mailing list. However, by revealing that the treatment did not affect attitudes about the mailing list is favorable in and of itself, because it showed that attitudes about the mailing list did not decrease after receiving the treatment.

When testing the last hypothesis with a one-way ANOVA test, there were no significant differences indicated on the instructor and course ratings between the distance education and traditional group. This is a positive result, because it indicates that the two groups had similar experiences and attitudes towards the course and the instructor. This reveals that the mode of educational delivery did not affect overall course and instructor ratings in this particular experiment.

Limitations of the Research

Before detailing the recommendations for further research, it is important to state some of the general research observations made by the researcher. This was the first time the instructor not only taught the course but also taught any course by satellite/CMC. This was also the first mailing list course the researcher had moderated. Needless to say, lack of experience with the medium for both the instructor and the moderator may have impacted the results of the research experiment.

Some social and technological problems were the encountered with the mailing list. In order to ensure participation, it was decided to make contributions mandatory for the mailing list. Many students resented being required to contribute. Others only had access to the mailing list at work, and stated they barely had enough time to do their jobs, much less make adequate contributions to the mailing list. Some subscribers were hesitant to post messages because they did not see any benefit in sending e-mail to complain or to show ignorance with the course subject. Some students viewed the mailing list as a positive tool to distribute homework assignments and to ask questions that went unasked

during class either because of a failed audio link or viewing of the taped-video broadcast. In general, students felt that the mailing list should be used to enhance the course, but not be included as a graded portion of the course.

The moderated mailing list program itself was cumbersome to moderate and some of the receiving sites had difficulty sending in messages for posting. Other sites had difficulty receiving messages that were posted to the mailing list. As these problems were encountered, the moderator and systems administrator handled them to the best of their ability. However, in dealing with other base systems administrators, some problems were not solved until half-way through the quarter. Even though the mailing list requirements were given out and briefed by the instructor on the first day of class, some students did not subscribe to the mailing list until late in the quarter. The number of postings by each individual and the date they subscribed to the mailing list can be found at Appendix D. The moderator forwarded all previously posted mailing list messages to the late subscribers, as well as to the subscribers who were experiencing technical difficulties.

A couple of the base education centers' test administrators did not administer the pre-course survey at the same time as the pretest. The course administrator realized there may have been some miscommunication, and resent some pre-course surveys to a few of the remote sites during the third week of class. Some of the pre-course survey data may be tainted because the treatment was already being administered (the mailing list/satellite course) when the base education centers administered the pre-course survey.

Three of the nineteen remote sites did not receive a live satellite broadcast. The original intent of this research project was to compare the taped-video, satellite and

traditional methods. However, since there were only six students from the taped sites, and only three of the six turned in pre- or post-course surveys, it was decided that the sample size for the video portion was not sufficient. Therefore, the taped-video students were considered with the satellite distance education group.

Recommendations for Further Research

It is recommended that this research project be conducted on other professional continuing education courses to determine if the results can be applied to other non-software engineering courses.

The requirement to use the mailing list may have discouraged students from participating. It would be interesting to conduct the experiment again without the mandatory mailing list participation requirement -- encouraging mailing list participation in other, more positive ways.

By duplicating this study on the same course with the same instructor, with an experienced mailing list moderator, the results may be more indicative of the treatment and not the inexperience. The study should also be repeated on groups with no significant demographic differences, to further examine the grade differences between groups. Perhaps groups with similar backgrounds will have no significant grade differences between the distance education and traditional groups.

Summary

The literature dealing with satellite distance education consistently indicates that the delivery of educational programming via satellite broadcast is educationally effective. However, typical satellite distance education methods have always had one big drawback -- limited interaction. Some academic institutions, like the Air Force Institute of Technology, are using computer-mediated communication to provide its remote students with a tool to interact during non-class hours. This was the first deliberate attempt by the Air Force Institute of Technology to electronically communicate with its satellite distance education students.

The objective of this research was to examine an Air Force software engineering Professional Continuing Education distance education course to determine if computer-mediated communication supplemented satellite distance education delivery is as good as or better than the traditional face-to-face education delivery method. In particular, this study examined whether the CMC supplemented satellite distance education course performance, interaction, and attitude outcomes were at least as good as the traditional face-to-face education course outcomes.

This research effort used a non-equivalent control group methodology to analyze the performance, interaction, and attitude outcomes of the Air Force Institute of Technology's School of Systems and Logistics Software Engineering Departments' (AFIT/LSS) Object Oriented Analysis and Design (CSE 494) Software Professional Development Program course. The results of the demographic and computer attitudes data revealed that the two groups were significantly different in only two areas-- educational level and self-rated

computer proficiency -- with the traditional group rating higher on both accounts. The significant differences on these items can give insight to the observed differences found between the two groups on performance outcomes. Significant differences were found between the groups on the pretest, final exam and overall course grades, but not on the midterm grades. With the traditional group having higher education levels and self-assessed computer proficiency ratings, it is not surprising that they scored higher on the pretest and final than the distance education group did. However, this assessment does not explain the midterm grades. When examining midterm grades, there were no significant differences between the two groups, indicating that distance education students can perform as well as traditional students on certain measurements of academic performance.

When examining the interaction outcomes, there were no significant differences on student-to-student and student-to-instructor interaction rates between the two groups. This indicates that the mailing list enabled the distance education group to achieve comparative interaction rates to the traditional group. By providing remote students with a communication tool that allows interaction during non-class hours, the feelings of isolation and solitude for the remote student can be lessened and possibly eliminated.

After examination of attitudes towards computers and expectations towards the mailing list with participation rates for the distance education students, it was revealed that there were no significant differences between positive and negative computer attitudes and expectations for the mailing list with mailing list participation rates. This is somewhat surprising because other research has indicated that more positive pre-course attitudes

towards computers and the educational medium will lead to higher participation rates. However, there were many other factors that may have affected participation rates that this researcher either did not study or could not study.

Upon conclusion of the experiment, this researcher examined pre-course and post-course attitudes towards the mailing list. It was discovered that there were no significant differences between the pre-course expectations about using the mailing list and post-course experiences with the mailing list. In other words, the treatment did not affect the distance education students' attitudes towards the mailing list.

When examining instructor and course ratings, the two groups had similar experiences and attitudes towards the course and the instructor, revealing that the mode of educational delivery does not affect overall satisfaction with the course and the instructor. This indicates that the effectiveness of the instruction was perceived to be the same by both the distance education group and the traditional group.

Despite some negative findings in relation to course performance, the overall results of this study were encouraging. They suggest that satellite distance education that is supplemented with computer-mediated communication can be an effective educational delivery method for software engineering Professional Continuing Education courses. After examining some of the limitations of this research project -- instructor inexperience with the class and delivery medium, researcher inexperience with the mailing list, student dissatisfaction with the mandatory participation requirement, technical problems with the mailing list and late administration of some pre-course surveys -- further research is recommended in particular areas. Some of these areas include: investigating similar

research experiments that incorporate positive encouragement for mailing list participation, duplicating this research experiment with the same instructor (who is now experienced with the course and the medium) and course, and conducting a similar experiment on two groups with no significant demographic differences.

With the continuing need to reach more students with less money, it is very important for the Air Force to develop an effective distance education method that allows for interaction. Satellite distance education is now available at most Air Force bases, and with more and more bases becoming connected to the Internet, the possibilities for interaction using computer-mediated communication are endless. Distance education initiatives, like the one here at the Air Force Institute of Technology, need to be evaluated and improved so that the greatest benefit from educational technology can be realized.

Appendix A: Software Engineering Course Listing

Air Force Institute of Technology
Software Engineering Department
Software Professional Development Course Listing

Course Number	Course Title
CSE 492	Software Systems Engineering
CSE 493	Software Requirements and Design Engineering
CSE 494	Object Oriented Analysis and Design Engineering
CSE 495	Software Creation and Maintenance
CSE 496	Software Engineering Practicum (offered in residence only)

Appendix B: Mailing List Handout

CSE 494 Mailing List Handout

The Object-Oriented Analysis and Design Software Professional Development Course will be using a mailing list program to supplement the satellite and videotaped classroom sessions. The mailing list program is intended to provide asynchronous discussion sessions for the distance education students. Homework assignments will be distributed over the mailing list. Students are encouraged to ask questions, provide feedback and give comments on the course and the medium of course delivery. Active involvement with the mailing list will count toward your CSE 494 class participation grade.

Distance education students are required to:

1. Subscribe to the mailing list by the end of the first week.
2. Check the mailing list for electronic mail messages at least twice a week.
3. Make adequate contributions to the mailing list at least once every two weeks.

To subscribe to the mailing list:

Send electronic mail to: spdp-request@afit.af.mil
Content of e-mail message: subscribe 494 "your name"

To post messages to the mailing list:

Send your topic or questions for discussion in an e-mail message to this address:
494@lss.afit.af.mil
All of the current mailing list subscribers will receive a copy of your e-mail message.

To contact Capt. Cecil with individual messages, send e-mail to:
dcecil@lss.afit.af.mil

Note: The instructor may forward your electronic mail to the mailing list if your message will add value to the discussion session.

All subscribers to the mailing list will receive the electronic mail messages that are sent to the mailing list. This mailing list is moderated. All messages will be approved by the moderator before the message is posted to the mailing list. Therefore, there may be some lag time between when you send a message and when it actually is posted to the mailing list. The mailing list will be checked, at a minimum, each day by 1100.

The moderator for this mailing list is Capt. Megan C. Block. Questions about the mailing list should be e-mailed to: curranm@lss.afit.af.mil.

Distance education students without access to electronic mail need to contact the mailing list moderator. Capt. Block can be reached at (513) 427-2731 or DSN 785-7777 (ext. 2123). An alternate method to receive the information will be discussed.

Appendix C: Requirements, Timeframe and POC Listing
Software Engineering Distance Education Research Project

Requirement	Timeframe	POC
1. Develop pretest	By 30 June	Capt Cecil
2. Develop pre-course survey	By 30 June	Capt Block
3. Send out Pretest and pre-course Survey	By 3 July	Course Admin/Capt Block
4. Administer Pretest and pre-course Survey	2nd day of class	Test Admin/Capt Cecil.
5. Discuss Mailing List with Students	1st day of class	Capt Cecil
*How to subscribe	1st day of class	Capt Cecil
*Who can subscribe (DE only, not WP students)	1st day of class	Capt Cecil
*What type of info will be sent out by Capt Cecil	1st day of class	Capt Cecil
*Students need to: subscribe to Mailing List	By end of 1st week	DE Student
check mailing list	Twice a week	DE Student
make adequate contributions	Bi-weekly	DE Student
6. Get info to DE students that don't have e-mail	Day of dissemination	Capt Block
7. Get info to WP students not allowed access	Before/after class	Capt Cecil/Capt Block
8. Perform admin on moderated Mailing List	Each day before 1100	Capt Block
*Subscribe students	Daily-as needed	Capt Block
*Forward appropriate messages	Daily-as needed	Capt Block
*Work with Sys admin on errors/problems	Daily-as needed	Capt Block
9. Contribute info for Mailing List	2-3 Times a week	Capt Cecil
10. Assist Capt Cecil with homework	as needed	Capt Block
11. Grade Pretest	Before midterm	Course Admin/Capt Cecil
12. Perform Stat Analysis on pre-course survey	Before midterm	Capt Block
13. Develop/send out midterm	11 Aug	Capt Cecil/Course Admin
14. Administer midterm	18 Aug	Test Administrator
15. Grade Midterm	Just after midterm	Course Admin/Capt Cecil
16. Develop post-course survey/final	Before midterm	Capt Block/Capt Cecil
17. Send out final and post-course survey	15 Sept	Course Admin/Capt Block
18. Administer final and post-course survey	18 Sept	Test Administrator

19. Grade Final	Just after final	Course Admin/Capt Cecil
20. Perform Stat Analysis on post-course survey	Just after final	Capt Block

Appendix D: CSE 494 Mailing List Postings

Type	SSAN	Participation	Date signed Up
DE	1360	2	25-Jul
DE	5671	2	1-Aug
DE	6647	5	10-Jul
DE	9792		26-Jul
DE	3030		20-Jul
DE	3475	1	11-Jul
DE	9796	1	19-Jul
DE	214		11-Jul
DE	9831	1	12-Jul
DE	2481	4	17-Jul
DE	4244		20-Jul
DE	1587		12-Jul
DE	6270	4	11-Jul
DE	9753		14-Jul
DE	9140	2	14-Jul
DE	7099	1	17-Jul
DE	3763		11-Jul
DE	6564	1	11-Jul
DE	3395		20-Jul
DE	3824		13-Jul
DE	3110	1	11-Jul
DE	2890		24-Jul
DE	4375	3	19-Jul
DE	7213		19-Jul
DE	4213	3	10-Aug
DE	5331	1	18-Jul
DE	6626	3	25-Jul
DE	5080		14-Jul
DE	5539	1	11-Jul
DE	9947	1	12-Jul
DE	7192	3	14-Jul
DE	1160	1	11-Jul
DE	4944	3	11-Jul
DE	7795		14-Jul
DE	588	1	11-Jul
DE	1297		12-Jul
DE	580		14-Jul
DE	7486	2	26-Jul

*** This doesn't include 5 or 6 messages sent directly to Capt Cecil and then combined and sent out on 18 July. This also does not include 24 responses to a survey on software engineering conducted by Capt Cecil.

Appendix E: Pre-course survey

Pre-course Software Engineering Survey

The Air Force Institute of Technology is conducting a study on the effectiveness of distance education in comparison to traditional education. The Software Engineering Department of the School of Systems and Logistics has approved research on their software engineering courses. This survey is one of the instruments that will be used in the study of the effectiveness of your software engineering course delivered in the distance education mode (supplemented with computer-mediated communication) compared to the course offered in the traditional face-to-face mode. Survey data will be collected at the beginning and ending of this course. All surveys will be anonymous and responses will be non-attributable. Your participation in filling out this survey is strictly voluntary and greatly appreciated. There will be no impact on your grade if you choose not to participate. Please answer all survey questions completely and honestly.

Thank you for your time and effort.

Captain Dan Cecil
Captain Megan Curran Block

Directions: Indicate your responses by answering in the blanks provided or by circling the appropriate response.

Name (optional) _____
Last four digits of your social security number (for coding purposes only) _____

1. Male _____ Female _____ 2. Age _____

3. Are you military or civilian? Military _____ Civilian _____ 4. What is your Rank or Grade? _____

5. What is your Air Force Specialty Code or job series? _____

6. What is your current job title? _____

7. How long have you been assigned to your current job? _____ years _____ months

8. Is your current job related to software engineering? yes _____ no _____

9. How long have you worked in the software engineering field? _____ years _____ months _____ N/A

10. What is your highest level of education? (please list degree type)
    Undergraduate degree _____
    Some Graduate courses _____
    Graduate degree _____
    Other _____

11. How many undergraduate software engineering credits have you completed? _____

12. How many graduate software engineering credits have you completed? _____

13. How many professional continuing education software engineering courses have you taken? _____

14. How much out-of-class time do you expect to dedicate to this course each week?
    1-less than one hour 2- one to two hours 3- two to three hours 4-three or more hours

15. Do you have access to a computer that can connect to the Internet?
    1-yes 2- no

16. If you answered yes to question 15, where is the computer located?
    1- at home 2- at work 3- other _____

17. How would you rate your proficiency with personal computers?
    1-no experience 2-new user 3-moderately proficient 4-proficient 5-very proficient

18. Have you ever taken a satellite distance education course?
    1- yes 2- no
    If yes, From which institution did you take this course? _____

19. Have you ever taken a satellite course supplemented with computer-mediated communication?
    1-yes 2-no
    If yes, From which institution did you take this course? _____

20. How often have you used an electronic-mail system?

Frequently						Never
1	2	3	4	5	6	7

21. Have you ever been a member of an electronic mailing list system?
    1- yes 2- no

For each of the following pairs of words, please chose the response that is the closest to your CURRENT FEELINGS ABOUT USING COMPUTERS. For instance, if you feel computer systems in general are completely "stimulating" to use and not at all "dull," circle 1; 4 means you are undecided or neutral, or think they are equally likely to be stimulating or dull; 3 means you feel that they are slightly more stimulating than dull, etc.

22.	Stimulating	1	2	3	4	5	6	7	Dull
23.	Fun	1	2	3	4	5	6	7	Dreary
24.	Easy	1	2	3	4	5	6	7	Difficult
25.	Personal	1	2	3	4	5	6	7	Impersonal
26.	Helpful	1	2	3	4	5	6	7	Hindering
27.	Non threatening	1	2	3	4	5	6	7	Threatening
28.	Efficient	1	2	3	4	5	6	7	Inefficient
29.	Obliging	1	2	3	4	5	6	7	Demanding
30.	Desirable	1	2	3	4	5	6	7	Undesirable

If you are a Wright-Patterson student, please stop here. Questions 31-39 apply to satellite students only.

An electronic mailing list program allows messages to be shared among an established group of people. Individuals who subscribe to the mailing list will receive all electronic mail messages that are sent to the mailing list. Replies to those mailing list messages are also sent to all of the mailing list members. Mailing list programs enable sharing information with a group a people who have related interests.

Indicate your expectations about using a mailing list system by choosing the number that best indicates where your feelings lie on the scales below.

31.	Easy to learn	1	2	3	4	5	6	7	Hard to learn
32.	Friendly	1	2	3	4	5	6	7	Impersonal
33.	Not frustrating	1	2	3	4	5	6	7	Frustrating
34.	Productive	1	2	3	4	5	6	7	Not productive

35. Do you expect that the use of the mailing list system will increase the efficiency of your education (the quantity of your work that you can complete in a given time)?

Definitely yes	1	2	3	4	5	6	7	Definitely not

36. Do you expect the use of the mailing list system will increase the quality of your education?

Definitely yes	1	2	3	4	5	6	7	Definitely not

37. Do you resent being required to use the mailing list system for this course?

Definitely yes	1	2	3	4	5	6	7	Definitely not

38. Overall, how useful do you expect the mailing list system to be for this course?

Very Useful	1	2	3	4	5	6	7	Not useful at all

39. While you are part of this course, how much time in the average week do you foresee yourself using the mailing list system in relation to your coursework?

1- less than 30 minutes 2- 30 minutes to one hour 3- 1 to 2 hours 4- 3 to 4 hours 5- 5 hours or more

Questions 22-39 of this survey instrument were developed by Starr Roxanne Hiltz for the evaluation of the Virtual Classroom (registered trademark) found in Chapter 7 (p.134) of Online Education: Perspectives on a New Environment, edited by Linda M. Harasim, 1991. These questions were used with permission.

Thank you for completing this survey. We appreciate your time and effort. An executive summary of the study results can be provided upon request.

Appendix F: Pre-course Survey Explanation

Explanation of Choices for Pre-course Survey
Questions 1-13 and 16

1. Sex Male - 1 Female - 2

2. Age XX years

3. Military - 1 Civilian - 2

4. Rank or Grade MSgt, 2Lt, 1Lt, GS-11 - 1
Capt , Major, GS-12, GS-13 - 2

5. Civilian Job Series or Air Force Specialty Code*
Computer Specialist 334 - 1
Mechanical Engineering 830 - 2
(Unknown - no entry in the AFP) 854 - 3
Electronics Engineering 855 - 4
Mathematics 1520 - 5
Computer Science 1550 - 6
Military Communication/Computers Officer 3351/3 - 7
Military Communication/Computers NCO 3C0X1 - 8
Other - 9

6. Current Job Title Mathematician - 1
Electronic Engineer - 2
Software Engineer - 3
Software Analyst - 4
Computer Engineer - 5
Computer Programmer - 6
Computer Scientist - 7
Database Administrator - 8
Computer Systems Analyst - 9
Project Manager - 10
Other - Computer related title - 11
Other - Non-computer related title - 12

7. Length of time assigned to current job XXX months

8. Current job related to Software Engineering yes - 1 no - 2

9. Length of time in Software Engineering field XXX months

10. Highest level of education
    Undergraduate degree - 1
    Some Graduate courses - 2
    Graduate degree - 3
    Other - 4

11. Number of Undergraduate Software Engineering credits X

12. Number of Graduate Software Engineering credits X

13. Number of PCE Software Engineering courses X

16. Computer location
    At home - 1
    At work - 2
    Other - 3
    At home and at work - 4

Appendix G: Post-course Survey

Post-course Software Engineering Survey

The Software Engineering Department at the Air Force Institute of Technology has been conducting a study on the effectiveness of distance education in comparison to traditional education. This survey is the last instrument that will be used in the study of the effectiveness of your software engineering course delivered in the distance education mode (supplemented with computer-mediated communication) compared to the course offered in the traditional face-to-face mode. As mentioned in the previous study, all surveys will remain anonymous and your responses are non-attributable. Your participation in this survey remains voluntary and is greatly appreciated. Please answer all survey questions completely and honestly.

Thank you again for your time and effort.

Captain Dan Cecil
Captain Megan Curran Block

Directions: Indicate your responses by answering in the blanks provided or by circling the appropriate response.

Name (optional) _____ Location _____
Last four digits of your social security number (for coding purposes only) _____
Primary Method of Delivery: Satellite _____ Live Lecture _____ Taped Lecture _____

1. How much out-of-class time did you dedicate to this course each week?
   1-less than one hour 2- one to two hours 3- two to three hours 4-three or more hours

2. How often did you communicate with other students outside of class, by computer, "face-to-face" or on the telephone?
   1-never 2-rarely 3-sometimes 4-often 5-frequently 6-constantly

3. How often did you communicate with your instructor outside of class, by computer, "face-to-face" or on the telephone?
   1-never 2-rarely 3-sometimes 4-often 5-frequently 6-constantly

For the next three questions, choose the number that best describes where your feelings lie on the scale listed below each statement.

4. Students in my class tended to be:
   Extremely cooperative 1 2 3 4 5 6 Not at all cooperative

5. The help I received from other students was:
   Crucially important to me 1 2 3 4 5 6 Useless or misleading

6. This course was more of a/an:
   Individual experience 1 2 3 4 5 6 Group experience

7. The instructor organized this course well.
   1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

8. Grading was fair and impartial.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

9. The instructor seems to enjoy teaching.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

10. The instructor has sufficient knowledge about this subject area.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

11. Students were encouraged to express ideas.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

12. The instructor presented material clearly and summarized main points.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

13. The instructor discussed points of view other than his own.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

14. Students were able to get personal help from the instructor in this course.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

15. The instructor presented the material in an interesting manner.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

16. The instructor critiqued my work in a constructive and helpful way.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

17. Overall, I would rate this instructor as:
1-Excellent 2-Very good 3-Good 4-Fair 5-Poor

18. This course made me more interested in the subject.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

19. I learned a great deal of factual and useful material.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

20. I gained a good understanding of basic concepts.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

21. I learned to identify central issues in this field.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

22. I developed the ability to communicate clearly about this subject.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

23. This course was a good use of my time.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

24. I developed new friendships in this class.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

25. I learned to value other points of view.
1-Strongly agree 2-Agree 3-Not sure 4-Disagree 5-Strongly disagree

26. Overall, I would rate this course as:
1-Excellent 2-Very good 3-Good 4-Fair 5-Poor

If you are a Wright-Patterson student, please stop here. Questions 27-37 apply to satellite students only.

27. How much time in the average week did you use the mailing list system in relation to your coursework?

1- less than 30 minutes 2- 30 minutes to one hour 3- 1 to 2 hours 4- 3 to 4 hours 5- 5 hours or more

Indicate your experiences with the mailing list system by choosing the number that best describes where your feelings lie on the scales below.

28.	Easy to learn	1	2	3	4	5	6	7	Hard to learn
29.	Friendly	1	2	3	4	5	6	7	Impersonal
30.	Not frustrating	1	2	3	4	5	6	7	Frustrating
31.	Productive	1	2	3	4	5	6	7	Not productive

32. Did the use of the mailing list system increase the efficiency of your education (the quantity of your work that you completed in a given time)?
Definitely yes 1 2 3 4 5 6 7 Definitely not

33. Did the use of the mailing list system increase the quality of your education?
Definitely yes 1 2 3 4 5 6 7 Definitely not

34. Did you find the course to be a better learning experience than normal face-to-face courses?
Definitely yes 1 2 3 4 5 6 7 Definitely not

35. Did you learn a great deal more because of the mailing list?
Definitely yes 1 2 3 4 5 6 7 Definitely not

36. Would you choose to take another course that is supplemented with a mailing list?
Definitely yes 1 2 3 4 5 6 7 Definitely not

37. Overall, how useful was the mailing list system for this course?
Very Useful 1 2 3 4 5 6 7 Not useful at all

Some questions of this survey instrument were developed by Starr Roxanne Hiltz for the evaluation of the Virtual Classroom (registered trademark) found in Chapter 7 (p. 134) of Online Education: Perspectives on a New Environment, edited by Linda M. Harasim, 1991. These questions were used with permission.

Thank you for completing this survey. We appreciate your time and effort. An executive summary of the study results will be provided to you upon request.

Appendix H: Variables and Measurement

Software Engineering Distance Education Research Project
Variables and Measurement

Dependent Variables	**Measurement**
Performance Outcomes	Grades on Pretest, Midterm, Final, Overall
Attitude Outcomes	Results of Precourse & Postcourse survey
Attitudes toward computers	Pre 22-30
Time expectation about the course	Pre 14
Time spent on course	Post 1
Expectations about the mailing list/CMC	Pre 31-38
Experience with the mailing list	Post 28-31
Overall Rating of CMC portion of course	Post 32-37
Time expectation about the mailing list	Pre 39
Time spent using mailing list	Post 27
Course Rating	Post 18-26
Instructor Rating	Post 7-17
Individual vs. Group Learning	Post 4-6
Interaction Outcomes	
Student-to-student	Post 2
Student-to-instructor	Post 3
Independent Variables	
Characteristics of Individuals	
Computer proficiency	Pre 17
Level of education	Pre 10
Experience with software engineering courses	Pre 11,12,13
Experience with satellite courses	Pre 18
Experience with satellite/CMC courses	Pre 19
Experience with e-mail, mailing list	Pre 20,21
Age	Pre 2
Military or Civilian	Pre 3
Rank/Grade	Pre 4
Sex	Pre 1
AFSC or job series	Pre 5
Current job title	Pre 6
Time in current job	Pre 7
Current job related to S/W Engr.	Pre 8
Time working in S/W Engr. field	Pre 9
Context variables	
Primary mode of course delivery	
Traditional face-to-face	Post -intro
Satellite/CMC	Post -intro
Number of students at each site	From Denise
Instructor's experience with medium	As determined by instructor
Instructor's experience with course	As determined by instructor
Convenient access to a computer with Internet connection	Pre 15,16
Intervening variables	
Technical problems with the satellite broadcast	
Technical problems with the mailing list	

Bibliography

AFIT School of Systems and Logistics Professional Continuing Education FY95 Catalog, PCE course catalog, Air Force Institute of Technology, Wright-Patterson AFB OH, 1995.

Barker, Bruce O., and Marvin R. Platten. "Student Perceptions on the Effectiveness of College Credit Course Taught via Satellite," The American Journal of Distance Education, 2: 44-50 (February 1988).

Barreau, Deborah, Cheryl Eslinger, Kim McGoff, and Cynthia Tonnesen. "Group Collaboration in the Virtual Classroom: An Evaluation of Collaborative Learning in the Virtual Classroom of CMCS 828S and the Technology That Supports It." University of Maryland Research Project Results, 1994.

Campbell, Donald T., and Julian C. Stanley. Experimental and Quasi-experimental Designs for Research, Rand McNally College Publishing Company, Chicago, 1963.

Cheng, Hui-Chuan, James Lehman and Penny Armstrong. "Comparison of Performance and Attitude in Traditional and Computer Conferencing Classes," The American Journal of Distance Education, 5:3 51-64 (1991).

Cookson, Peter S., from Michael G. Moore's (Ed) Contemporary Issues in American Distance Education, Oxford, Pergamon Press, 1990.

Cooper, Donald R., and C. William Emory. Business Research Methods, Irwin, Chicago, 1995.

Dunning, Becky S., Marvin J. Van Kekerix, and Leon M. Zaborowski. Reaching Learners Through Telecommunications. San Francisco: Jossey-Bass Publishers, 1993.

Gransden, Gregory. "Distance Education in Russia," The Chronicle of Higher Education, A41 (26 January 1994).

Harris, Mark C. An Approach for the Distance Delivery of AFIT/LS Resident Degree Curricula. MS Thesis GIR/LSR/91D-9. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, December 1991 (AD-A243887).

Hiltz, Starr Roxanne. "Measuring Acceptance of Computer-Mediated Communication Systems," Journal of the American Society for Information Science, 40:6 386-397 (1989).

Hiltz, Starr Roxanne. "User Satisfaction With Computer-Mediated Communication Systems," Management Science, 36:6 739-764 (June 1990).

Hiltz, Starr Roxanne, from Linda Harisim's (Ed) Online Education: Evaluating the Virtual Classroom, Praeger, New York, 1990.

Hiltz, Starr Roxanne, "Learning in a Virtual Classroom," International Journal of Man-Machine Studies, 39: 71-98 (1993).

Hudson, H.E., and C.H. Boyd. Distance Learning: A Review for Educators. ERIC Document Reproduction Service, ED 246 872 (1984).

Jacobson, Robert L., "Extending the Reach of 'Virtual' Classrooms," The Chronicle of Higher Education, A19-A23 (6 July 1994).

Jegede, Olugbemiro J., Barry Fraser and Darrell Fisher Curtin. "The Development and Validation of Distance and Open Learning Environment Scale," Educational Technology Research and Development, 43:1 90-93 (1994).

Kinnaman, Daniel E. "Evaluating Technology Programs," Technology & Learning, 12: 12-18 (April 1992).

Kline, John A. "Distance Learning -- Curriculum Analysis and Media Selection." Evaluation Document for Air University. Air University, Maxwell AFB AL, 1993.

Lewis, Chad T. and Terri Hedegaard. "Online Education: Issues and *Some* Answers," The Higher Education Journal, 20:9 68-71 (April 1993).

Moore, M. G., and M.M. Thompson. The Effects of Distance Learning: A Summary of Literature, University Park PA: The American Center for the Study of Distance Education, 1990.

Morgan, William and Francis M. Sheets. "The Interactive "Global Classroom: A Model From the DoDDS," The Higher Education Journal, 19:10 60-62 (May 1992).

Odasz, Frank from Michael D. Waggoner's (Ed) Empowering Networks: Computer Conferencing in Education, Educational Technology Publications, New Jersey, 1992.

Phelps, Ruth H., and Rosalie A. Wells, Robert L. Ashworth, Jr., and Heidi A. Hahn. "Effectiveness and Costs of Dista nce Education Using Computer-Mediated Communication," The American Journal of Distance Education, 5: 7-19 (1991).

Rossman, Parker. The Emerging Worldwide Electronic University. Westport CT, Greenwood Press, 1992.

Selfe, Cynthia L., and Susan Hilligoss, Literacy and Computers, New York, The Modern Language Association of America, 1994.

Smith, Richard, "Guest Lecture for Roadmap Distance Education Workshop." Electronic Message. ECS9411101631B@afit.af.mil, 10 November 1994.

Souder, William E. "The Effectiveness of Traditional vs. Satellite Delivery in Three Management of Technology Master's Degree Programs," The American Journal of Distance Education, 7: 37-53 (1993).

Taylor, Frank. "ACSC goes world-wide with distance learning," The Sheppard Senator, 1 September 1995: 2.

Verduin, John R., and Thomas A. Clark. Distance Education: The Foundations of Effective Practice, San Francisco, Jossey-Bass Publishers, 1991.

Willis, Barry. Distance Education Strategies and Tools, Englewood Cliffs NJ, Educational Technology Publications, 1994.

Vita

Captain Megan Curran Block was born on 3 June 1969 in Enid, Oklahoma. After graduating from Supreme Headquarters Allied Powers Europe (SHAPE) High School, Casteau, Belgium in 1987, she received a four-year Air Force Reserve Officer Training Corps (AFROTC) technical scholarship. In September of 1987, she enrolled in the University of Tampa, and received her AFROTC training at the University of South Florida, also in Tampa, Florida. Captain Block graduated Cum Laude with a Bachelors of Science in Management Information Systems in May of 1991. She received her commission into the United States Air Force as an AFROTC distinguished graduate. Four months after commissioning, she entered active duty as a second lieutenant as an information management officer for the Air Force Institute of Technology's School of Civil Engineering and Services. She served as the Academic Support Division Chief until May of 1994, when she was selected to attend the School of Logistics and Acquisition Management in the Graduate Information Resource Management Program. Capt. Block's next assignment is as the Base Information Management Flight Chief at Incirlik AB, Turkey.

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